To Katie, Anastasia, Erin and Gemma
and
to my parents.

VOLATILE AND PRECIOUS METAL GEOCHEMISTRY OF THE MOUNT ISA ORES AND THEIR HOST ROCKS

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ABSTRACT

Geochemical and petrographic investigations of Pb-Zn-Ag mineralization (12 orebody) and Cu-Co mineralization (1100 orebody) from Mount Isa were undertaken. Over one hundred and twenty carefully selected samples were analyzed for major and minor elements and for some or all of the following volatile metals: Au, Ag, Cd, As, Sb, Se, Bi, Co and Tl.

A strong Tl enrichment is observed in (pyritic) unmineralized lateral equivalents of 12 orebody for several kilometers to the north of the mine sequence. The Se and As contents, S/Se ratios and S isotope relationships in the Pb-Zn ores and their host pyritic shales preclude a magmatic or deep-seated hydrothermal S source. The data suggest that sulfide S in the Urquhart Shales was derived from reduction of a "seawater"/evaporitic/pore water sulfate source.

Lateral variations in the thickness of mineralized intervals, the nature of the sulfide-gangue textures in the ores, the pervasive K and Tl enrichment in the host rocks and other chemical features of the Pb-Zn ores indicate that much of the Mount Isa mineralization formed epigenetically within the unconsolidated Urquhart Shales.

The Pb-Zn-Ag ores contain very little Au and it is argued that this feature is best explained by the hydrothermal solutions that formed the Pb-Zn ores being cool ($<<200^{o}C$) and moderately oxidized.

The "silica dolomite" (the host to all the Mount Isa Cu mineralization) formed from "normal" Urquhart Shale as a result of intense fault-related hydrothermal activity (Perkins, 1984). The alteration has silicified the shales adjacent to the fault, and dolomite, phyllosilicates and "immobile" elements liberated during the silicification have been re-deposited at higher levels up-dip in the silica dolomite bodies. For the most part primary sulfide textures have not been preserved.

It is argued that the distribution of several elements (notably Co, Bi, As, Fe and S) in 1100 orebody and its location down-dip from a strongly pyritic section of Urquhart Shale are good evidence that stratiform Co (and Cu) mineralization was present in pyritic Urquhart Shales prior to formation of the silica dolomite. Chemical and isotopic evidence suggests that the Cu mineralization had a

similar S-source and formed from similar solutions to the Pb-Zn-Ag ores.

A new co-genetic model for the Mount Isa Cu and Pb-Zn-Ag deposits in which the mineralization formed from cool oxidized solutions in the upper few meters of the unconsolidated Urquhart Shales is presented. The metal-bearing solutions were expelled from their source rocks (oxidized clastic sediments lower in the Mount Isa Group) during the course of normal basin compaction and dewatering. Base metal sulfides were fixed by sulfate reduction processes occuring in the diagenetic environment of the Urquhart Shales. Weathered mafic volcanic detritus may have been an important component of the source.

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